IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of: Mandal, et al.	§		
Serial No.: 10/091,699	§	Group Art Unit:	2814
Confirmation No.: 7928	§	Examiner:	Steven H. Rao
Filed: March 4, 2002	§		
For: Very Low Dielectric Constant Plasma-Enhanced CVD Films	§		

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May 14, 2004 (Date) — (Signature)

Dear Sir:

APPEAL BRIEF

Applicants submit this Appeal Brief to the Board of Patent Appeals and Interferences on appeal from the decision of the Examiner of Group Art Unit 2814 dated January 28, 2004, finally rejecting claims 1, 5-8, 16, 18, and 21-38. Please charge the fee of $330.00 for filing this brief to Deposit Account No. 20-0782/AMAT/3771.Y1/KMT. Three copies of this brief are submitted for use by the Board.

Real Party in Interest

The present application has been assigned to Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, California 95054.

Related Appeals and Interferences

Appellant asserts that no other appeals or interferences are known to the Appellant, the Appellant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

Status of Claims

Claims 1, 5-8, 16, 18, and 21-38 are pending in the application. Claims 1-20 were originally presented in the application. Claims 2-4, 9-15, 17, and 19-20 have been canceled. Claims 26-38 were originally presented in a preliminary amendment filed with an RCE on May 20, 2003. Claims 21-25 from the Second Response to Final Office Action dated February 26, 2003 that was filed on May 16, 2003 by facsimile were entered upon filing of the RCE. Claims 26-38 were re-presented in the Response to Office Action dated August 28, 2003 that was filed on November 3, 2003 and were then entered. Claims 1, 5-8, 16, 18, and 21-38 stand rejected in view of several references as discussed below. The rejection of claims 1, 5-8, 16, 18, and 21-38 based on the cited references is appealed. The pending claims are shown in the attached Appendix.

Status of Amendments

No amendments to the claims were submitted after the Final Office Action dated January 28, 2004. Arguments presented after final rejection were not accepted by the Examiner.

Summary of Invention

The present invention generally provides methods of depositing low dielectric constant films. One aspect of the invention provides a method for depositing a low dielectric constant film by plasma enhanced chemical vapor deposition of one or more compounds comprising at least one oxidizable silicon containing component and at least one non-silicon containing component having thermally labile groups. The labile groups decompose to gaseous products and leave voids in the film (paragraph [0012]).

The at least one oxidizable silicon containing component and at least one non-silicon containing component having thermally labile groups may be in the same

molecule (paragraph [0013]) or different molecules (paragraph [0015]). In one aspect, a siloxane and at least one oxidizable chemical comprising a member selected from the group consisting of tertiarybutyl, tertiarybutoxy, furfuryl, furfuryloxy, and neopentyl are reacted with an oxidizing gas at a temperature that retains the member in a conformal layer. The member is then converted to dispersed voids (paragraphs [0032] and [0041]).

In another aspect, the one or more compounds comprising at least one oxidizable silicon containing component and at least one non-silicon containing component having thermally labile groups includes a silicon-containing compound comprising a member selected from the group consisting of tertiarybutyl, tertiarybutoxy, furfuryl, furfuryloxy, and neopentyl (paragraphs [0043] and [0044]).

In a further aspect, a siloxane comprising two or more silicons and four or more methyl groups bonded to the silicons and a non-silicon containing component that is a cycloalkene component such as dioxinyl, furyl, or furfuryl are reacted with an oxidizing gas (paragraphs [0013], [0014], and [0033]) to form a film.

Issue Presented

1. Whether the Examiner erred in rejecting claims 1, 5-8, 16, 18, and 21-38 under 35 U.S.C. § 103(a) as being unpatentable over *Grill* in view of *Scholsky, et al.*

Grouping of Claims

Pending claims 1, 5-8, 16, 18, and 21-38 do not stand or fall together for all arguments presented by Applicants. Applicants' first argument relates to claims 1, 16, 18, 21, 26-28, and 35-36, and claim 1 is representative of the claims. Applicants' second argument relates to claims 5-8, 29-32, and 37-38, and claim 5 is representative of the claims. Applicants' third argument relates to claims 22-25 and 33-34, and claim 22 is representative of the claims.

ARGUMENT

I. THE EXAMINER ERRED IN REJECTING CLAIMS 1, 16, 18, 21, 26-28, and 35-36 BECAUSE *GRILL* IN VIEW OF *SCHOLSKY, ET AL.* DOES NOT TEACH, SHOW, OR SUGGEST REACTING A SILOXANE AND AT LEAST ONE OXIDIZABLE CHEMICAL COMPRISING A MEMBER SELECTED FROM THE GROUP CONSISTING OF FURFURYL, FURFURYLOXY, AND NEOPENTYL WITH AN OXIDIZING GAS, AS RECITED IN CLAIM 1.

Claims 1, 16, 18, 21, 26-28, and 35-36 stand rejected under 35 U.S.C. § 103 over *Grill* (U.S. Patent No. 6,312,793) in view of *Scholsky, et al.* (U.S. Patent No. 5,010,166) on grounds that it would have been obvious to one of ordinary skill in the art of use *Scholsky, et al.'s* aldehydes to be a furfuryl or furfuryloxy or neopentyl compound in place of *Grill's* unspecified aldehydes, etc., the motivation to make the above substitution is to form a low dielectric thermoset coating (film) having superior hardness, flexibility, and impact resistance (*Scholsky, et al.*, column 1, lines 35-38) (See Final Office Action dated January 28, 2004, p. 4). Applicants respectfully traverse the rejection.

The Examiner asserts that *Scholsky, et al.* in column 16 lines 16 and 62 describes the use of furfuryl or furfuryloxy and neopentyl compounds to form a low dielectric thermoset coating (film) having superior hardness, flexibility, and impact resistance. Applicants submit that while *Scholsky, et al.* in column 16 lines 16 and 62 lists compounds including furfuryl and neopentyl groups, there is no teaching in any part of *Scholsky, et al.* to use compounds including furfuryl and neopentyl groups to form a low dielectric thermoset coating (film), as *Scholsky, et al.* does not describe the formation of low dielectric constant coatings or films. *Scholsky, et al.* describes forming thermoset coatings having superior hardness, flexibility, and impact resistance (column 1, lines 35-38), but does not teach or suggest thermoset coatings that have a low dielectric constant.

Applicants note that claim 1 of the instant application only recites a low dielectric constant film in the preamble of the claim, and thus, the recitation of a low dielectric

constant film in claim 1 does not provide the basis for patentability of claim 1. Claim 1 does recite, "converting the member to dispersed voids", which lowers the dielectric constant. However, as the Examiner's only original basis for combining *Grill* and *Scholsky, et al.* was his assertion that it would have been obvious to use *Scholsky, et al.'s* compounds in *Grill's* process to form a low dielectric thermoset coating (film) having superior hardness, flexibility, and impact resistance as described in *Scholsky, et al.*, Applicants have noted the absence of a teaching of the formation of low dielectric constant films in *Scholsky, et al.*, and thus have asserted that there is no motivation to use the compounds of *Scholsky, et al.* in *Grill's* process of forming a low dielectric constant film.

In the Advisory Action dated April 21, 2004, the Examiner further asserted that *Grill* in column 5 line 67 describes PECVD and in column 6 describes a process very similar to the process of *Scholsky, et al.*, and that therefore, one of ordinary skill in the art would be motivated to combine the teachings of *Grill* and *Scholsky, et al.* Applicants agree that column 5 line 67 of *Grill* describes performing a process in a PECVD chamber. However, while column 6 of *Grill* describes a PECVD chamber, column 6 of *Grill* does not describe a process similar to the process of *Scholsky, et al. Scholsky, et al.* describes a liquid-based process of depositing thermoset, polymeric coatings from precursors that are not taught or suggested to contain silicon. *Grill* describes a vapor deposition process in which a precursor mixture including silicon is reacted with an oxidizing gas to deposit a silicon-containing, low dielectric constant film. Thus, Applicants maintain that the Examiner has not mentioned a suggestion of the invention in the combined teachings of *Grill* and *Scholsky, et al.*

Therefore, *Grill* in view of *Scholsky, et al.* does not teach, show, or suggest a method for depositing a low dielectric constant film, comprising introducing a siloxane comprising two or more silicons and from two to five carbons bonded to the silicons into a processing chamber, introducing at least one oxidizable chemical comprising a member selected from the group consisting of furfuryl, furfuryloxy, and neopentyl into the processing chamber, reacting the siloxane and the at least one oxidizable chemical with an oxidizing gas at a temperature that retains the member in a conformal layer, and

converting the member to dispersed voids, as recited in claim 1. Applicants respectfully request reversal of the rejection of claim 1 and of claims 16, 18, 21, 26-28, and 35-36, which depend thereon.

II. THE EXAMINER ERRED IN REJECTING CLAIMS 5-8, 29-32, AND 37-38 BECAUSE *GRILL* IN VIEW OF *SCHOLSKY, ET AL.* DOES NOT TEACH, SHOW, OR SUGGEST REACTING AT LEAST ONE OXIDIZABLE CHEMICAL COMPRISING A MEMBER SELECTED FROM THE GROUP CONSISTING OF FURFURYL, FURFURYLOXY, AND NEOPENTYL, WHEREIN THE AT LEAST ONE OXIDIZABLE CHEMICAL COMPRISES SILICON, WITH AN OXIDIZING GAS, AS RECITED IN CLAIM 5.

Claims 5-8, 29-32, and 37-38 stand rejected under 35 U.S.C. § 103 over *Grill* in view of *Scholsky, et al.* on grounds that *Grill* in view of *Scholsky, et al.* teaches an oxidizable chemical comprising silicon and a furfuryl, fufuryloxy, or neopentyl group (p. 8, Final Office Action dated January 28, 2004). Applicants respectfully traverse the rejection.

Applicants maintain that *Scholsky, et al.* does not teach or suggest an oxidizable chemical that includes silicon and a furfuryl, furfuryloxy, or neopentyl group, as *Scholsky, et al.* does not describe silicon containing compounds. *Grill* provides silicon containing compounds but does not teach or suggest that the silicon containing compounds include a furfuryl, furfuryloxy, or neopentyl group. There is no suggestion in *Scholsky, et al.* or the combination of *Grill* and *Scholsky, et al.* of reacting compounds comprising both silicon and a furfuryl, furfuryloxy, or neopentyl group.

In the Advisory Action dated March 19, 2004, the Examiner further asserted that *Grill* and *Scholsky, et al.* teach compounds containing both silicon and aldehyde. The Examiner cites *Grill* and states that it is known that furfuryl, furfuryloxy, and neopentyl groups are aldehydes. The Examiner further states that *Scholsky, et al.* describes compounds containing a furfuryl, furfuryloxy, or neopentyl group. Applicants agree that *Scholsky, et al.* describes compounds that include furfuryl, furfuryloxy, or neopentyl groups. However, Applicants respectfully submit that furfuryl, furfuryloxy, and neopentyl

compounds are not aldehydes as furfuryl (-CH=CH-C(CH_2)=CH-O-)), furfuryloxy (-O-CH_2-(-CH=CH-C=CH-O-), and neopentyl ((CH_3)$_3$-C-C) groups do not include a C=O bond. Moreover, Applicants note that claim 5 does not require a compound that includes both a silicon and an aldehyde, and thus, the Examiner's assertions regarding compounds containing both silicon and an aldehyde are irrelevant to the patentability of claim 5.

In the Advisory Action dated April 19, 2004, the Examiner raised a new argument with respect to claim 5. The Examiner asserted that Applicants' previous arguments regarding a compound comprising both silicon and a furfuryl, furfuryloxy, or neopentyl group is not commensurate in scope with claim 5, which does not require a compound comprising both silicon and a furfuryl, furfuryloxy, or neopentyl group, but rather recites the two compounds (a silicon containing compound and a furfuryl, furfuryloxy, or neopentyl containing compound) being separately introduced as two different reactants. Applicants respectfully submit that claim 5 clearly recites introducing at least one oxidizable chemical comprising a member selected from the group consisting of furfuryl, furfuryloxy, and neopentyl into a processing chamber, wherein the at least one oxidizable chemical comprises silicon and does not recite two compounds being separately introduced into the chamber as two different reactants.

Therefore, *Grill* in view of *Scholsky, et al.* does not teach, show, or suggest a method for depositing a low dielectric constant film, comprising introducing at least one oxidizable chemical comprising a member selected from the group consisting of furfuryl, furfuryloxy, and neopentyl into the processing chamber, wherein the at least one oxidizable chemical comprises silicon, reacting the at least one oxidizable chemical with an oxidizing gas at a temperature that retains the member in a conformal layer, and converting the member to dispersed voids, as recited in claim 5. Applicants respectfully request reversal of the rejection of claim 5 and of claims 6-8, 29-32, and 37-38 which depend thereon.

III. THE EXAMINER ERRED IN REJECTING CLAIMS 22-25 AND 33-34 BECAUSE *GRILL* IN VIEW OF *SCHOLSKY, ET AL.* DOES NOT TEACH, SHOW, OR SUGGEST REACTING A SILOXANE COMPRISING TWO OR MORE SILICONS AND

FOUR OR MORE METHYL GROUPS BONDED TO THE SILICONS AND AT LEAST ONE OXIDIZABLE CHEMICAL COMPRISING A CYCLIC RING CONSISTING OF CARBON AND OXYGEN WITH AN OXIDIZING GAS, AS RECITED IN CLAIM 22.

Claims 22-25 and 33-34 stand rejected under 35 U.S.C. § 103 over *Grill* in view of *Scholsky, et al.* on grounds that *Grill* in view of *Scholsky, et al.* teaches reacting a siloxane comprising two or more silicons and four or more methyl groups bonded to the silicons and at least one oxidizable chemical comprising a cyclic ring consisting of carbon and oxygen. Applicants respectfully traverse the rejection.

Applicants maintain that Applicants' assertion that *Grill* does not teach compounds that include a cyclic ring consisting of carbon and oxygen is correct. The Examiner states (in the Advisory Action dated March 19, 2004) that Applicants' argument with respect to *Grill*'s failure to name compounds that include a cyclic ring consisting of carbon and oxygen is at odds with the teachings of *Grill* which specify compounds at least in column 3, lines 12-24. Column 3, lines 12-24 of *Grill* describe a first precursor selected from molecules containing at least some of Si, C, O, and H atoms, such as tetramethylcyclotetrasiloxane, tetraethylcyclotetrasiloxane, decamethylcyclopenta-siloxane, and methylsilanes, that may optionally be combined with oxidizing molecules such as O_2 or N_2O. The named precursors have cyclic rings that consist of silicon and oxygen with carbon attached to the cyclic ring. Thus, *Grill* does not teach or suggest an oxidizable chemical comprising a cyclic ring consisting of carbon and oxygen.

In the Advisory Action dated April 19, 2004, the Examiner raised a new ground of rejection with respect to claim 22. The Examiner states that Applicants' arguments that *Grill* and *Scholsky, et al.* don't motivate or suggest reacting a siloxane with an oxidizable chemical comprising a cyclic ring consisting of carbon and oxygen are not commensurate in scope with claim 22 which recites reacting a siloxane with at least one oxidizable chemical with an oxidizing gas at a temperature that retains the cyclic ring in a conformal layer. Applicants respectfully submit that while claim 22 recites the elements listed by the Examiner, claim 22 also requires that the at least one oxidizable chemical comprises a cyclic ring consisting of carbon and oxygen. Applicants submit that the Examiner cannot ignore the limitation of a cyclic ring consisting of carbon and

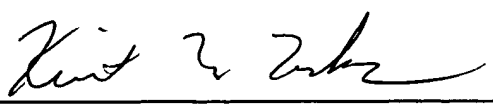
oxygen. Furthermore, Applicants submit that the Examiner has not shown a motivation or suggestion in *Grill* in view of *Scholsky, et al.* to react a siloxane and an oxidizable chemical comprising a cyclic ring consisting of carbon and oxygen with an oxidizing gas.

Thus, *Grill* in view of *Scholsky, et al.* does not teach, show, or suggest a method for depositing a low dielectric constant film, comprising introducing a siloxane comprising two or more silicons and four or more methyl groups bonded to the silicons into a processing chamber, introducing at least one oxidizable chemical comprising a cyclic ring consisting of carbon and oxygen into the processing chamber, reacting the siloxane and the at least one oxidizable chemical with an oxidizing gas at a temperature that retains the cyclic ring in a conformal layer, and converting the cyclic ring to dispersed voids, as recited in claim 22. Applicants respectfully request reversal of the rejection of claim 22 and of claims 23-25 and 33-34 which depend thereon.

Conclusion

In conclusion, *Grill* in view of *Scholsky, et al.* does not teach, show, or suggest reacting a siloxane and at least one oxidizable chemical comprising a member selected from the group consisting of furfuryl, furfuryloxy, and neopentyl with an oxidizing gas or reacting a siloxane and at least one oxidizable chemical comprising silicon and a member selected from the group consisting of furfuryl, furfuryloxy, and neopentyl with an oxidizing gas. Furthermore, *Grill* in view of *Scholsky, et al.* does not teach, show, or suggest reacting a siloxane and at least one oxidizable chemical comprising a cyclic ring consisting of carbon and oxygen with an oxidizing gas. Therefore, it is believed that the rejections made by the Examiner should be reversed. Thus, Applicants respectfully request reversal of the rejections and allowance of claims 1, 5-8, 16, 18, and 21-38.

Respectfully submitted,



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APPENDIX

1. (Previously Presented) A method for depositing a low dielectric constant film, comprising:

introducing a siloxane comprising two or more silicons and from two to five carbons bonded to the silicons into a processing chamber;

introducing at least one oxidizable chemical comprising a member selected from the group consisting of furfuryl, furfuryloxy, and neopentyl into the processing chamber;

reacting the siloxane and the at least one oxidizable chemical with an oxidizing gas at a temperature that retains the member in a conformal layer; and

converting the member to dispersed voids.

2-4. (Canceled)

5. (Previously Presented) A method for depositing a low dielectric constant film, comprising:

introducing at least one oxidizable chemical comprising a member selected from the group consisting of furfuryl, furfuryloxy, and neopentyl into a processing chamber, wherein the at least one oxidizable chemical comprises silicon;

reacting the at least one oxidizable chemical with an oxidizing gas at a temperature that retains the member in a conformal layer; and

converting the member to dispersed voids.

6. (Original) The method of claim 5, wherein the at least one oxidizable chemical is a silane.

7. (Original) The method of claim 6, wherein the silane is dimethylfurfuryloxy silane.

8. (Original) The method of claim 5, wherein the at least one oxidizable chemical is a disiloxane.

9-15. (Canceled)

16. (Previously Presented) The method of claim 1, wherein the siloxane is selected from the group consisting of 1,1,3,3-tetramethyldisiloxane, 1,3,5,7-tetramethylcyclotetrasiloxane, and octamethylcyclotetrasiloxane, and the at least one oxidizable chemical is dimethylfurfuryloxy silane.

17. (Canceled)

18. (Previously Presented) The method of claim 1, further comprising depositing a silicon carbide layer on the conformal layer prior to the converting the member to dispersed voids.

19-20. (Canceled)

21. (Previously Presented) The method of claim 1, wherein the at least one oxidizable chemical is difurfuryl ether.

22. (Previously Presented) A method for depositing a low dielectric constant film, comprising:

introducing a siloxane comprising two or more silicons and four or more methyl groups bonded to the silicons into a processing chamber;

introducing at least one oxidizable chemical comprising a cyclic ring consisting of carbon and oxygen into the processing chamber;

reacting the siloxane and the at least one oxidizable chemical with an oxidizing gas at a temperature that retains the cyclic ring in a conformal layer; and

converting the cyclic ring to dispersed voids.

23. (Previously Presented) The method of claim 22, wherein the oxidizable chemical is selected from the group consisting of vinyl-1,4-dioxinyl ether, vinyl furyl

ether, vinyl-1,4-dioxin, vinyl furan, methyl furoate, furyl formate, furyl acetate, furaldehyde, difuryl ketone, difuryl ether, difurfuryl ether, furan, and 1,4-dioxin.

24. (Previously Presented) The method of claim 22, wherein the oxidizable chemical is difurfuryl ether.

25. (Previously Presented) The method of claim 24, wherein the siloxane is selected from the group consisting of 1,1,3,3-tetramethyldisiloxane, 1,1,5,5-tetramethyltrisiloxane, 1,1,3,5,5-pentamethyltrisiloxane, 2,4,6-trisilaoxane, and cyclo-1,3,5,7-tetrasilano-2,6-dioxy-4,8-dimethylene.

26. (Previously Presented) The method of claim 1, wherein the dispersed voids are formed by annealing the substrate.

27. (Previously Presented) The method of claim 1, wherein the siloxane comprises four or more methyl groups bonded to the silicons.

28. (Previously Presented) The method of claim 1, wherein the siloxane is selected from the group consisting of 1,1,3,3-tetramethyldisiloxane, 1,1,5,5-tetramethyltrisiloxane, 1,1,3,5,5-pentamethyltrisiloxane, 2,4,6-trisilaoxane, cyclo-1,3,5,7-tetrasilano-2,6-dioxy-4,8-dimethylene, 1,3,5,7-tetramethylcyclotetrasiloxane, and octamethylcyclotetrasiloxane.

29. (Previously Presented) The method of claim 5, wherein the dispersed voids are formed by annealing the substrate.

30. (Previously Presented) The method of claim 5, further comprising introducing a siloxane comprising two or more silicons and from two to five carbons bonded to the silicons into the processing chamber and reacting the siloxane with the oxidizing gas.

31. (Previously Presented) The method of claim 30, wherein the siloxane comprises four or more methyl groups bonded to the silicons.

32. (Previously Presented) The method of claim 30, wherein the siloxane is selected from the group consisting of 1,1,3,3-tetramethyldisiloxane, 1,1,5,5-tetramethyltrisiloxane, 1,1,3,5,5-pentamethyltrisiloxane, 2,4,6-trisilaoxane, cyclo-1,3,5,7-tetrasilano-2,6-dioxy-4,8-dimethylene, 1,3,5,7-tetramethylcyclotetrasiloxane, and octamethylcyclotetrasiloxane.

33. (Previously Presented) The method of claim 22 wherein the dispersed voids are formed by annealing the substrate.

34. (Previously Presented) The method of claim 22, wherein the siloxane comprises four or more methyl groups bonded to the silicons.

35. (Previously Presented) The method of claim 1, wherein the oxidizing gas is carbon dioxide.

36. (Previously Presented) The method of claim 35, wherein the at least one oxidizable chemical comprises a neopentyl group.

37. (Previously Presented) The method of claim 5, wherein the oxidizing gas is carbon dioxide.

38. (Previously Presented) The method of claim 37, wherein the at least one oxidizable chemical comprises a neopentyl group.